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Dispersal Studies With Radioactively Tagged Spruce Beetles[1]

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Adults of the spruce beetle, Dendroctonus rufipennis (Kirby) (Coleoptera: Scolytidae), were tagged with radioactive iodine (I-131) and released to determine dispersal characteristics. About 4 percent were recovered. More beetles were recovered in easterly than in westerly quadrants, possibly because of light but variable westerly winds. Dispersal continued for 7 to 8 days after release. Beetles attacked the closer sample trees first and then more distant trees. Beetles infested with nematodes dispersed as far and in the same pattern as non-infested beetles.

KEY WORDS: Dendroctonus rufipennis, insect behavior, iodine isotopes, radioactive tracers.

Trap trees are frequently used to reduce or control localized populations of the spruce beetle, Dendroctonus rufipennis (Kirby). This method congregates the beetles by capitalizing on their natural attraction to freshly downed logs. Its success, however, depends partially on knowledge of the beetle's flight and dispersal habits. This Note reports on studies, conducted on two National Forests in Colorado in 1953 and 1954, designed to investigate these habits.

Methods

Hibernating adults were collected from the bases of infested trees on the White River National Forest in June 1953 and on the Uncompahgre National Forest in June 1954. Groups of 1,000 beetles (plus frass and bark) were spooned into pint cartons containing moist peat moss, and stored at 35° to 40° F.

Just prior to release, the beetles were removed from cold storage and allowed to regain field temperature. Groups of beetles were then immersed in a chilled 20 percent ethanol solution of radioactive iodine, I-131, in the release area.[3] After excess solution drained from the beetles, they were tumbled from the immersion vessel onto trays of aluminum foil. The trays were then transferred to preselected release points in the timber, and placed

[1] *Research reported here was conducted by R. H. Nagel, Entomologist, Rocky Mountain Station (now retired), J. M. Davis, Entomologist, Beltsville Forest Insect Laboratory, Beltsville, Maryland (now deceased); and A. E. Landgraf, Jr., Graduate Student, Duke University (now Entomologist, U. S. Forest Service, Washington, D. C.)*

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[3] *Davis, J. M., and Nagel, R. H. A technique for tagging large numbers of live adult insects with radioisotopes. J. Econ. Entomol. 49: 210-211. 1956.*

on the ground in shaded locations. One release point was established in each release area. The transfer and placement procedure held the gamma radiation at a safe level in the vicinity of the immersion apparatus, and prevented beetle mortality from exposure to direct sunlight. The immersion process usually left the beetles motionless for 15 to 30 minutes, and direct exposure to sunlight would have killed a high percentage of them. Bits of bark and twigs were added to the trays to provide additional protection and serve as points from which the beetles could fly. The immersion and release of 1,000 beetles took about 2 hours.

Beetles were released in even-aged, well-stocked stands of mature Engelmann spruce (Picea engelmannii Parry) on flat terrain in Colorado. Of the 42,700 beetles released during the study, 19,600 were released on the Routt National Forest in 1953, and 23,100 were released on the San Juan and Routt National Forest in 1954.

Sampling points were established at 20-chain intervals on a grid around the point of release (fig. 1). Sampling points were also located along the four cardinal directions at distances of 60 and 80 chains from the release point. This design provided sampling points in 24 directions, at distances from 14 to 80 chains.

At each sampling point, a green spruce tree was felled in an east-west direction about 1 week prior to beetle release. Since spruce beetles prefer shaded bark in which to construct egg galleries, the trees were not limbed until after beetle release. Felling the trees just prior to beetle release reduced the possibility of attacks by Ips or nontagged spruce beetles.

Scintillation counters were used to detect tagged beetles after they attacked the trees. During the first week after release, bark surfaces were scanned daily with the counters held 1 to 2 feet away. Three weeks after release, radiation was so reduced that the instruments had to be held within 1 inch of the bark surface. Detection of radioactive beetles was considered questionable 3 weeks after release.

Weather conditions during the release periods and for at least 1 week thereafter were generally fair. Winds were generally westerly but rarely exceeded 5 m.p.h. in the stand. Daytime temperatures were usually in the 60° to 70° F. range. Intermittent afternoon showers fell regularly.

About 180 beetles were relocated and examined for nematodes in 1954.

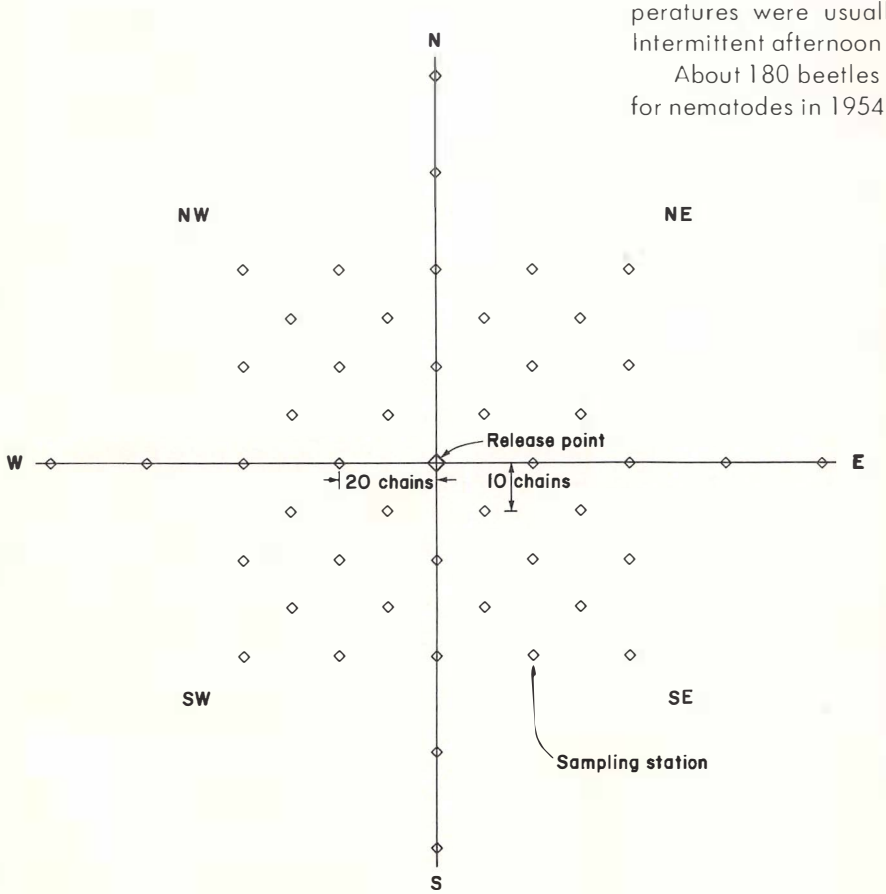

Figure 1.--
Design of the sample point grid system around a release point. Maximum sampling distance from release point was 80 chains.

Results and Discussion

Beetle Recovery

Of the 42,700 tagged beetles released, only 1,569 were recovered—an average of 4.4 percent or less in both years:

Date and location of release	Beetles-- Released (No.)	Recovered (No.)	Recovered (Pct.)
July 17, 1953 Routt NF	19,600	669	3.4
June 28, 1954 San Juan NF	4,300	69	1.6
July 3, 1954 Routt NF	18,800	831	4.4

Beetle recovery by quadrants was: northeast, 408; southeast, 454; southwest, 353; and northwest, 354. Ninety-seven beetles traveled 60 or more chains from the release point.

The reasons for the low recovery of beetles are not all known. About 15 percent of the beetles failed to leave the release stations. This loss was attributed to natural mortality and the effects of the radioactive material. The sampling system may be involved. Probably an undetermined number of beetles were lost because they attacked natural windfalls within the test area, but windfalls were neither counted nor surveyed for tagged beetles.

Also, some beetles may have flown beyond the limits of the test area (80 chains). Since 6 percent of those recovered (97 beetles) flew 60 chains or more, perhaps a portion of the test population flew beyond the outer sampling stations.

Dispersal

Direction of beetle dispersal was not uniform. Significantly more beetles were recovered in easterly than in westerly quadrants. Although windspeed during the release period rarely exceeded 5 miles per hour, the winds were generally from the west, which may account for the greater number of beetles recovered in the easterly quadrants.

Beetles continued to disperse for 7 to 8 days after release, but on the 20- and 40-chain sample trees, the greatest number of attacks were made within 3 to 5 days. The 1953 average daily count of beetles per tree on sample trees on each of the four cardinal directions at the 20- and 40-chain distances was:

Days since release:	20 chains (No. of beetles)	40 chains (No. of beetles)
2	2	0
3	20	2
4	27	3
5	32	3.2
6	34	4.6
7	36	4.6
8	33	3.2

Attacks at the 14-chain sample trees began the day after release, and were so numerous that a daily rate of increase could not be determined. Recoveries at the sample trees 60 or more chains from the release point were insufficient to measure daily increases. Equal numbers of males and females were recovered, both far from and close to the release point.

Trap Tree Location

The decrease in density of attacks with distance from the release point indicates that beetles may first attack the closest suitable host material, and then progressively work out to more distant material. This suggests that trap trees should be located at least within 10 to 20 chains of infested material or they may not be effective. The decrease in time of initial attack also supports this idea because the closer trees were attacked first. The 3- to 5-day interval between time of release and attack also suggests that trap trees 40 or more chains from an infested area might not be effective because beetles could locate closer suitable host material prior to locating the trap trees.

The decrease in the average daily counts of attacks was apparently due to re-emergence of the adults. This suggests that an adequate number of traps be felled so that, if beetles re-emerge and attack again, the traps could absorb them.

Dispersal of Beetles Infested With Nematodes

Beetles infested with nematodes dispersed in the same pattern as noninfested beetles. About equal numbers were recovered from the sample trees located 40 to 80 chains from the release point as well as from those trees 0 to 32 chains distant. This suggests that nematodes may not seriously affect the beetle's ability to disperse.

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